

## CLAIMS

What is claimed is:

1. Apparatus for determining paths for forwarding frames among end stations in a system of interconnected local area networks, comprised of:

first and second groups of frame forwarding devices known as bridges, which are used to interconnect local area networks;

a spanning tree cooperating with said groups of bridges for providing loop-free frame forwarding;

said first and second groups of bridges having means for determining tree paths for loop-free frame forwarding to an end station; and

said second group of bridges having further means cooperating with said first group of bridges to determine an alternate path for loop-free forwarding of a frame to an end station, which alternate path is shorter than any tree path to said end station.

2. The apparatus of Claim 1 wherein said second group of bridges are backward compatible with said first group of bridges, wherein the operation of said first group of bridges is unaltered by the presence of said second group of bridges, and

said second group of bridges inter-operate with said first group of bridges when at least one bridge of the latter group is present in the system, and

said second group of bridges can perform their functions in the absence of said first group of bridges in order to operate.

3. The apparatus of Claim 1 wherein said first group of bridges include means for performing a spanning tree bridge protocol (STBP) to determine a loop-free tree path for forwarding a frame to an end station; and

said second group of bridges including means for performing a spanning tree alternate routing bridge protocol (STAR BP) for determining said alternate path.

4. The apparatus of Claim 3 wherein said means for performing said spanning tree alternate routing bridge protocol includes means for performing said spanning tree bridge protocol.

5. The apparatus of Claim 1 wherein said end stations are distributed among said local area networks that are interconnected; and

said first and second groups of bridges selectively forward frames from end stations in one of said local area networks to end stations in another one of said local area networks.

6. The apparatus of Claim 1 wherein each bridge of the second group of bridges further comprises means for selecting a tree path when said means for determining an alternate path fails to identify an alternate path.

7. The apparatus of Claim 1 wherein selected ones of bridges of said second group are arranged along different tree paths and are joined by cross-links;

said means for determining said alternate paths including means for determining if a path including one of said cross-links provides a path shorter than a tree path.

8. The apparatus of Claim 7 wherein said means for determining alternate paths include means for ignoring cross-links whose end terminals are not connected to bridges of said second group.

9. The apparatus of Claim 7 wherein said means for determining alternate paths includes means for ignoring cross-links whose end terminals are joined to bridges lying along the same tree path.

10. The apparatus of Claim 1 wherein bridges of said second group are respectively arranged upstream and downstream of an intervening bridge of said first group in a common tree path and said upstream bridge of said second group including means for encapsulating a received frame with a source address and a destination address enabling transfer through the intervening bridge of said first group to the downstream bridge of said second group, wherein said transfer through the intervening bridge of the first group is in a downstream direction;

said intervening bridge including means for directing the encapsulated frame to said downstream bridge of said first group responsive to said destination address in accordance with normal frame forwarding over a tree path; and

said downstream bridge including means for stripping the encapsulated portions of an encapsulated frame and for forwarding said stripped encapsulated frame over a remaining portion of the forwarding path to an end station identified by a destination address incorporated as part of the unencapsulated frame.

11. The apparatus of Claim 1 wherein bridges of said second group are respectively arranged upstream and downstream of an intervening bridge of said first group in a common tree path and said downstream bridge of said second group including means for encapsulating a received frame with a source address and a destination address enabling transfer through the intervening bridge of said first group to the upstream bridge of said second group, wherein said transfer through the intervening bridge of the first group is in an upstream direction;

said intervening bridge including means for directing the encapsulated frame to said upstream bridge of said first group responsive to said destination address in accordance with normal frame forwarding over a tree path; and

said upstream bridge including means for stripping the encapsulated portions of an encapsulated frame and for forwarding said stripped encapsulated frame over a remaining portion of the forwarding path to an end station identified by a destination address incorporated as part of the unencapsulated frame.

12. The apparatus of Claim 1 wherein bridges of said second group include means for encapsulating a frame with at least a destination address of a bridge of said second group coupled to a bridge of said first group through a tree path;

said bridges of said first group including means responsive to said destination address for forwarding the encapsulated frame to the bridge identified by said destination address;

said bridges of said second group having means responsive to receipt of said encapsulated frame for stripping the frame of said encapsulation and forwarding the stripped frame to an end station identified by a destination address incorporated as part of said stripped frame.

13. The apparatus of Claim 1 wherein each bridge of said first and second groups include means for assigning a weighted metric to each port of the bridge;

means for exchanging said weighted metrics with other bridges in the system;

means for electing a root bridge responsive to the exchanged information;

means for determining a distance between each bridge and said root bridge;

means for building a unique spanning tree rooted at the root bridge in a distributed manner;

means for learning and remembering which port to forward a frame over said spanning tree to a given end station; and

means for storing said data.

14. The apparatus of Claim 13 wherein each bridge of said second group of bridges is further provided with means for conveying to other bridges of said second group information representing topology known to the conveying bridge;

means for conveying to other bridges of the second group information identifying bridges of the second group which are a source for frames and a destination for frames;

means for conveying to other bridges of the second group topology information known to bridges of the second group other than the conveying bridge; and

means for storing information received from other bridges of said second group for determining, if possible, an alternate path shorter than a corresponding tree path.

15. The apparatus of Claim 1 wherein each bridge of said second group is further provided with means for determining if another bridge of said second group is directly connected thereto by a cross-link which is a link that is not used to form any tree path; and

said means for determining an alternate path further including means for examining valid cross-links for use as segments of an alternate path, wherein a valid cross-link is

one whose end terminals are connected to bridges of said second group, and